Performance Evaluation and Reporting

A.K.A. Data Monitoring

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Decisions to Make Before You Start

- Is there something specific you'd like to know?
  - Fuel conversion efficiency, power output, battery state of charge, etc.
- Do you want to examine the functioning of the entire system?
  - Do you want to dedicate the man-power to do this?

System Monitoring Methods

- Continuous data acquisition
  - System performance/efficiency over a range of operating conditions, downtime, impending problems
- Field surveys
  - System performance/efficiency at specific operating points, component degradation
- Logbooks
  - Maintenance requirements, component reliability

Typical Monitoring Costs

• Install a DAS	$25-50k
• Field survey	$2-5K
• Logbooks	$500/year

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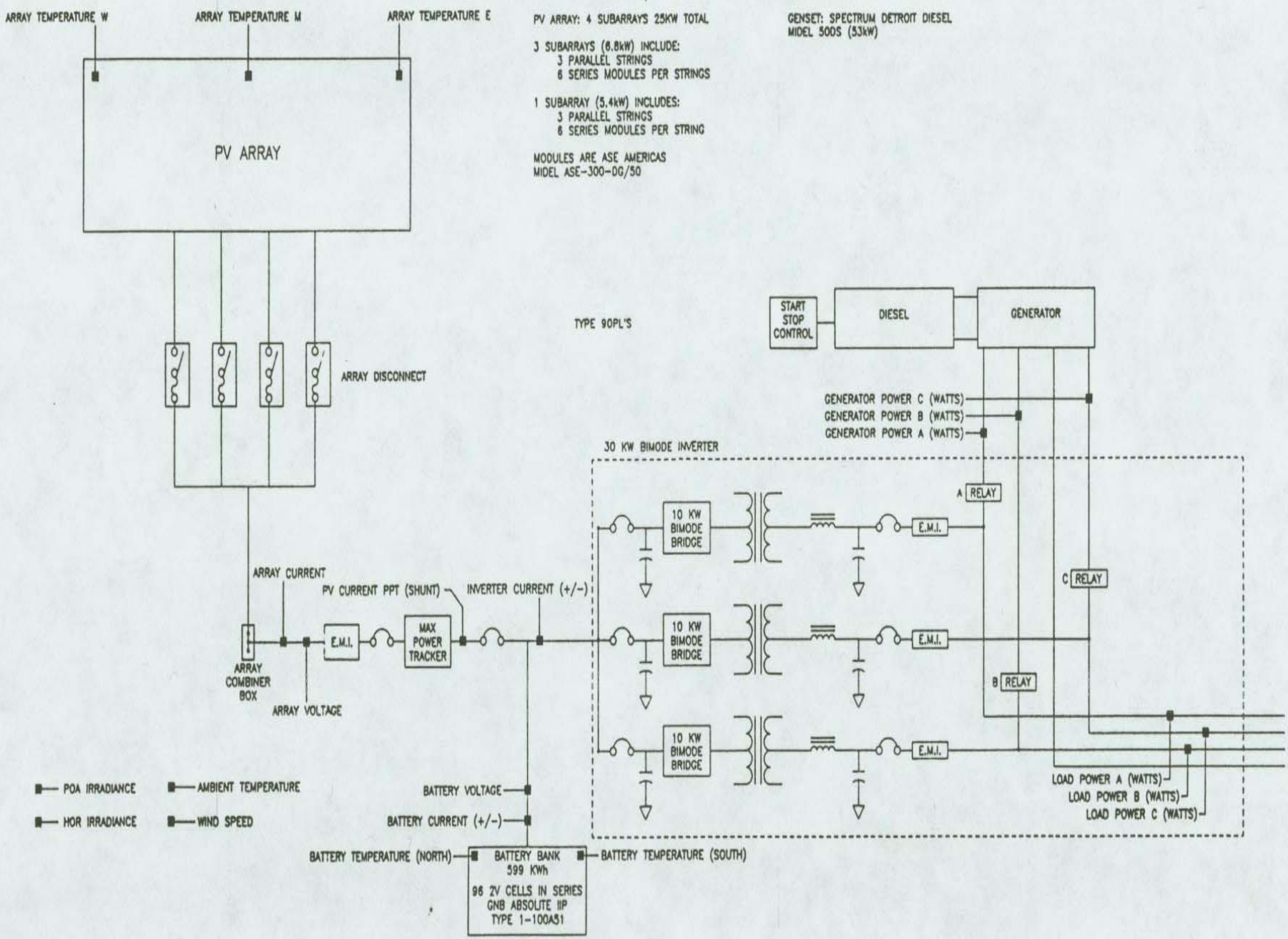

NOTE: PV CURRENT PPT, INVERTER CURRENT (+/-), AND BATTERY CURRENT (+/-) ARE MEASURED IN THE NEGATIVE LEG.

TABLE 1

Carol Spring Mountain Monthly Summary
July 1996

System Energy Balance	Total	%	Runtime	Fuel Usage
PV Array (DC)	1789.1 kWh	43.0		
Total Generator (AC)	+2371.6 kWh	57.0	220.4 Hours	259.7 Gallons
Total Facility Load (AC)	-3134.5 kWh			
Charge Balance + Losses	1026.2 kWh			

Battery	
Total Charging Energy (DC)	-1514.1 kWh
Total Discharging Energy (DC)	+1426.8 kWh
Net Battery Energy (DC)	-87.3 kWh
Round Trip Efficiency (± SOC)	94 %
Average Battery Voltage (DC)	205.3 V
Average Battery Temperature (South)	27.2 °C
Average Battery Temperature (North)	27.5 °C

Peak Power Tracker/Charger	
Average PV Array Voltage (DC)	286.6 V
Total PV Array Current (DC)	6.5 kAh
Average Battery Voltage (DC)	205.3 V
Total Peak Power Tracker Current (DC)	8.4 kAh
Charging Efficiency	86 %

Weather	Average
Ambient	22.1 °C
Module Middle (Daytime POA > 50)	38.7 °C
Module West (Daytime POA > 50)	38.7 °C
Module East (Daytime POA > 50)	39.1 °C

	Total	Daily
Plane of Array (32.5° Tilt)	122.6 kWh/m²	5.9 kWh/m²
Horizontal	130.4 kWh/m²	6.3 kWh/m²

MODE BREAKDOWN:	Number of Hours		Energy Generated		Average Efficiency
Mode 1 (S:Battery, L:Facility)	144.5 Hrs	(29.0%)	1142.1 kWh	(21.3%)	76.2 %
Mode 2 (S: PV+Battery, L:Facility)	61.2 Hrs	(12.3%)	505.5 kWh	(9.4%)	76.1 %
Mode 3 (S: PV, L: Facility+Battery)	69.6 Hrs	(14.0%)	1025.4 kWh	(19.1%)	86.3 %
Mode 4 (S:PV+Gen, L:Facility+Battery)	54.9 Hrs	(11.0%)	1081.1 kWh	(20.2%)	87.4 %
Mode 5 (S:Gen, L:Facility+Battery)	147.1 Hrs	(29.6%)	1608.1 kWh	(30.0%)	82.2 %
Fault	20.5 Hrs	(4.1%)			
Total	497.7 Hrs	100 %	5362.2 kWh	100 %	

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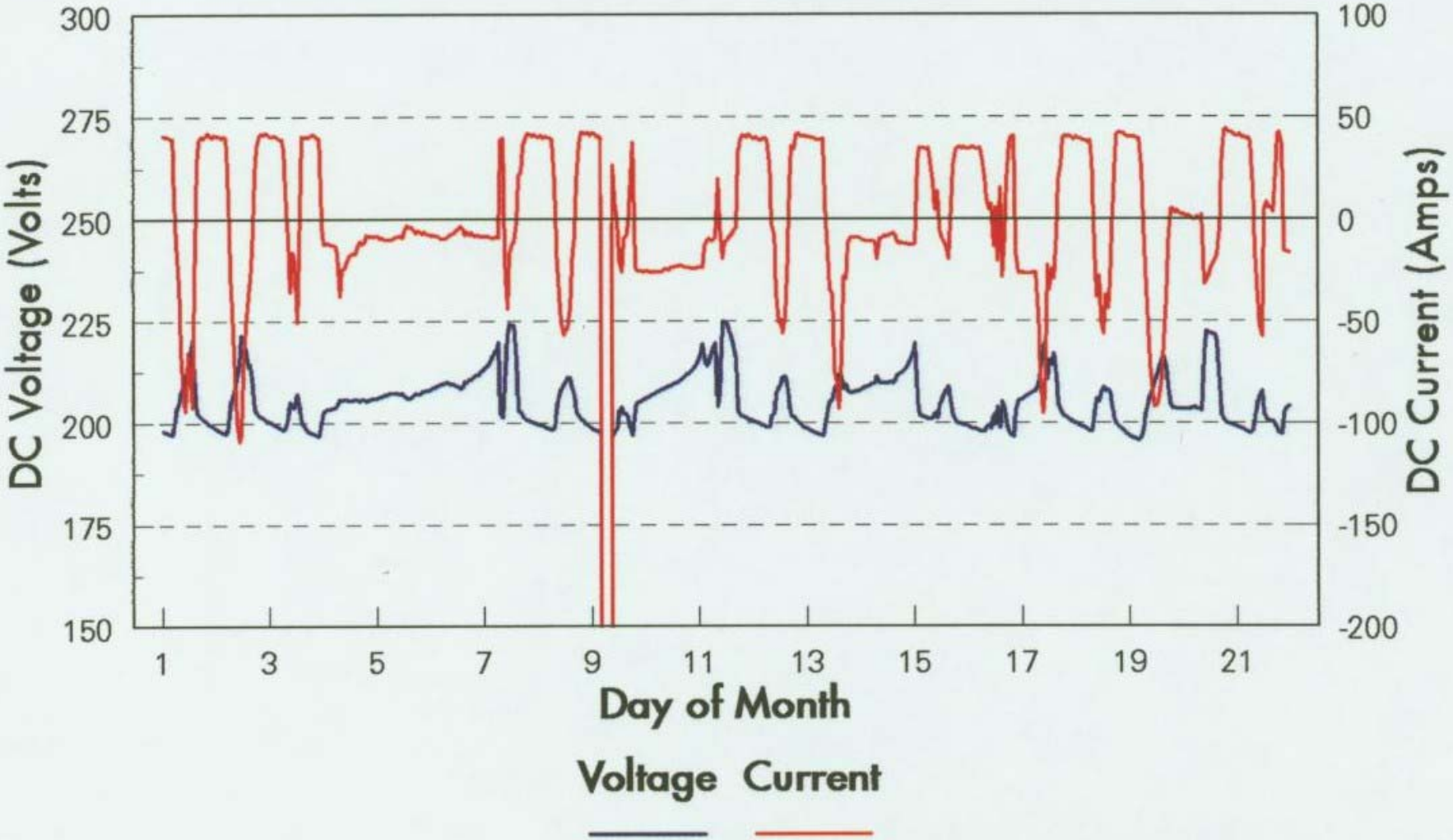
Carol Spring Mountain

Battery Voltage and Current: July 1996



Negative current indicates battery is charging.
Positive current indicates battery is discharging.

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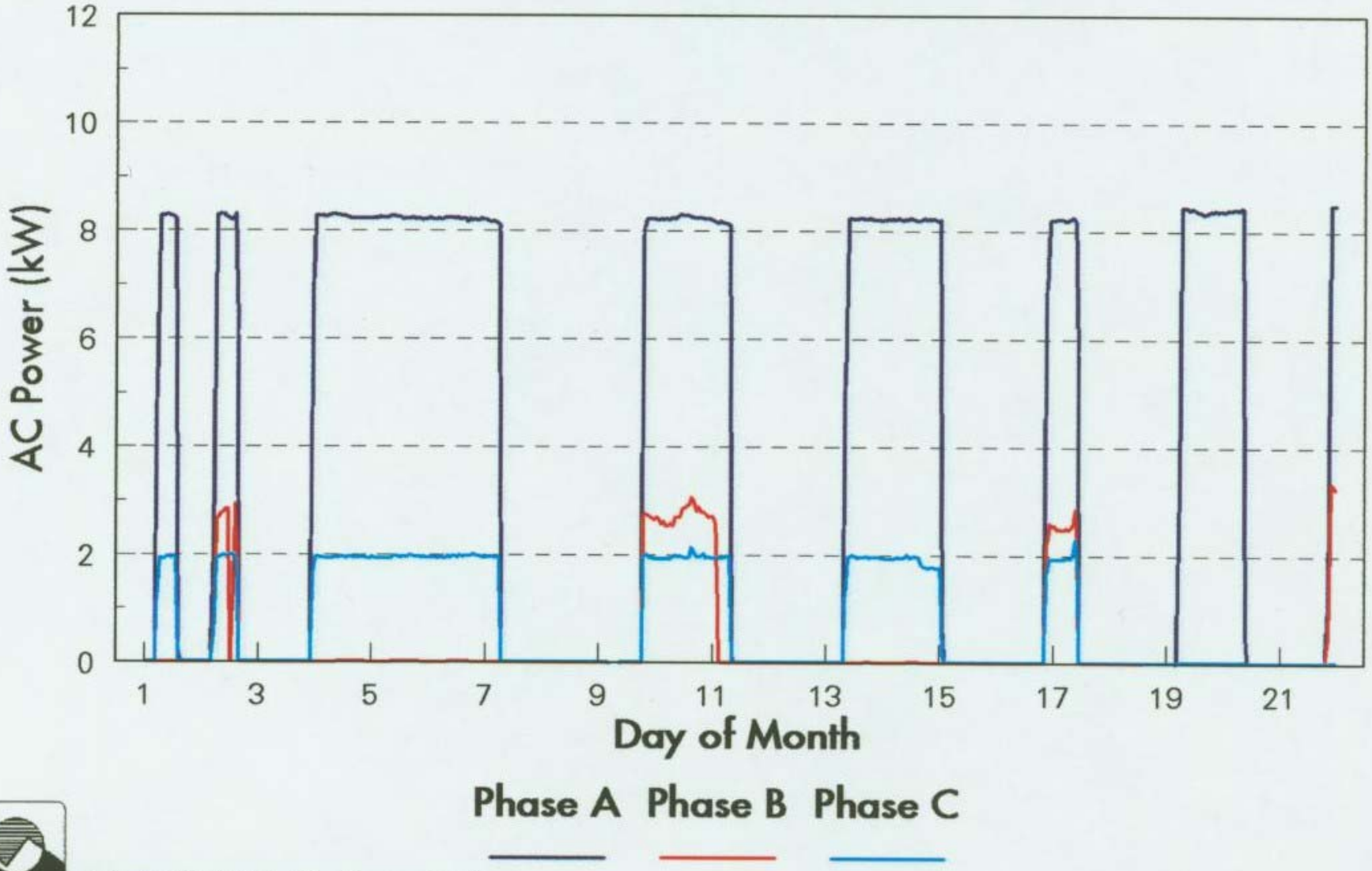
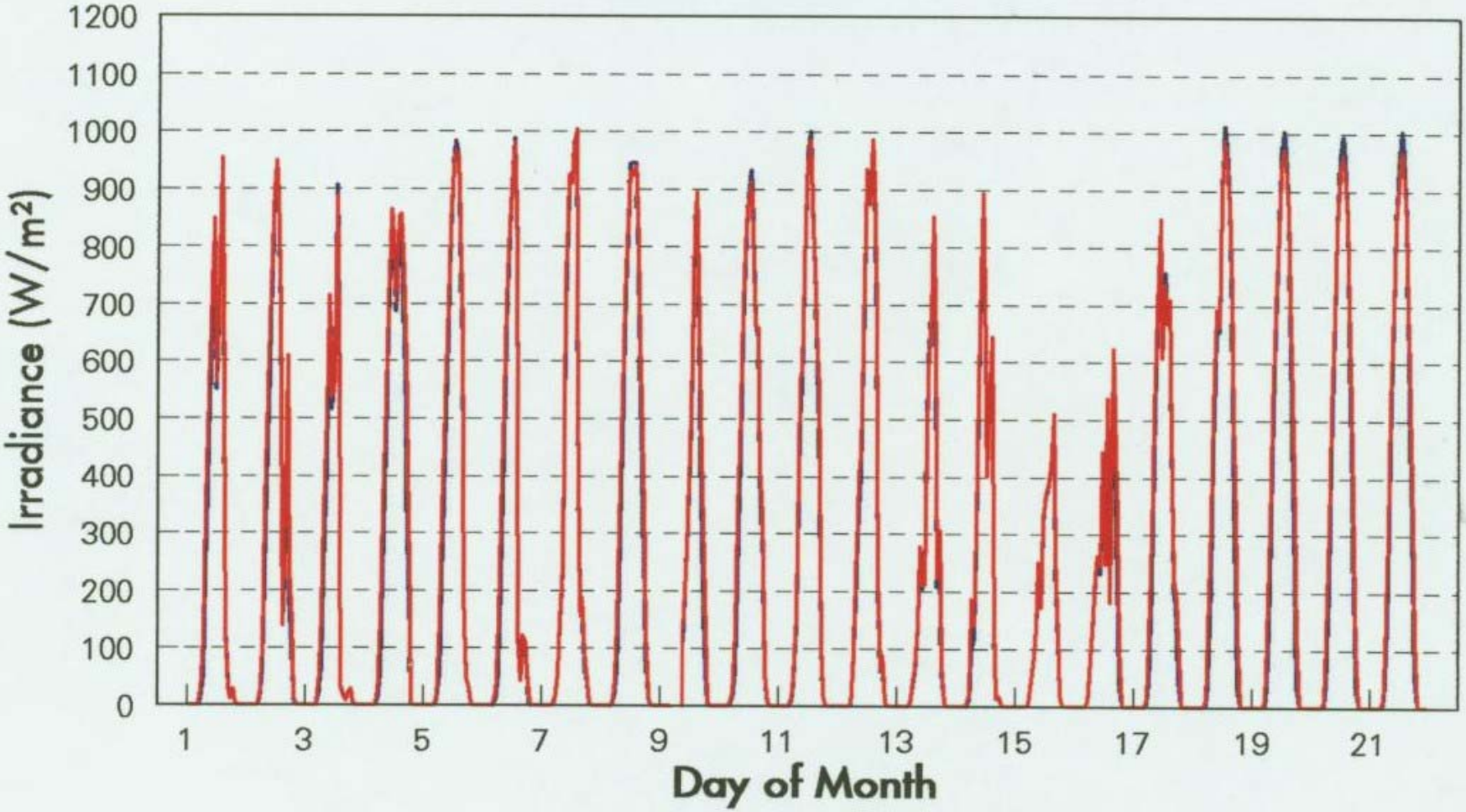
Figure 5

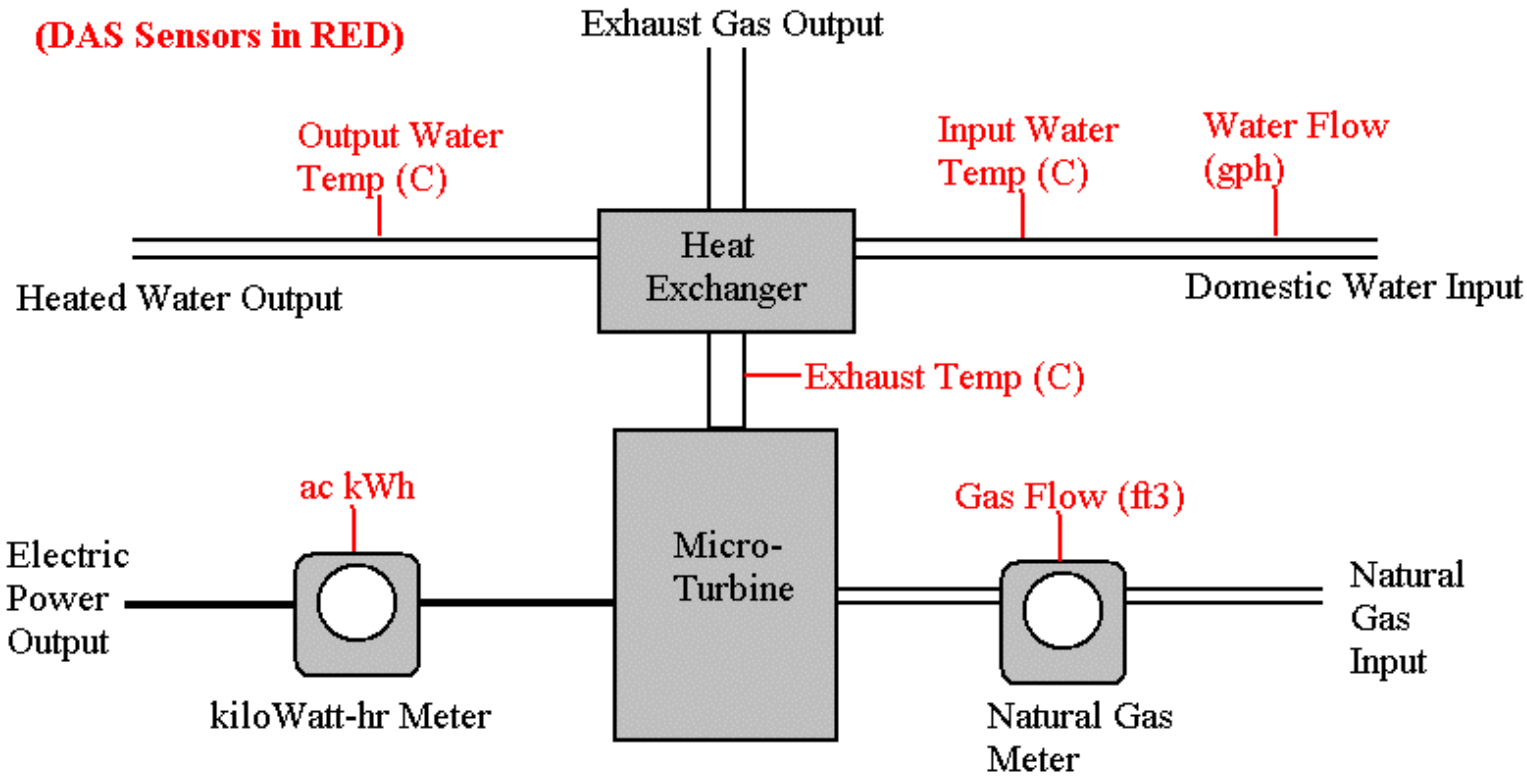
Carol Spring Mountain
Generator Power: July 1996



Carol Spring Mountain
Irradiance: July 1996



Typical Microturbine DAS Channels



Other DAS Channels:

Barometric Pressure
Ambient Temperature
Relative Humidity

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Performance Evaluation and Reporting Summary

- Data acquisition systems are expensive to install
- Analyzing the data can be even more expensive
- Make sure the information you want can't be obtained from field surveys or logbooks before installing a DAS
- If a DAS is called for, be sure it will provide what you need to know